



HELLS CANYON INITIATIVE

Restoration of bighorn sheep to
Hells Canyon

Annual report 2009 – 2010



Washington
Department of
**FISH and
WILDLIFE**



Photos by Mark Vekasy, Roblyn Brown, Vic Coggins, Mark Penninger, and Craig Johnson

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Hells Canyon Bighorn Sheep Restoration Committee 2009 - 2010

The Hells Canyon Bighorn Sheep Initiative is conducted by the Hells Canyon Bighorn Sheep Restoration Committee. The committee is composed of state and federal agencies, and the Wild Sheep Foundation, of which each provide an administrative (A) and technical (T) committee member. committee members and affiliation in 2009 - 2010 were:

Idaho Department of Fish and Game

- Dale Toweill, Wildlife Program Coordinator (A)
- Frances Cassirer, Project Coordinator/Wildlife Research Biologist (T)

Oregon Department of Fish and Wildlife

- Don Whitaker, Program Coordinator (A)
- Vic Coggins, District Wildlife Biologist (T)

Washington Department of Fish and Wildlife

- Donny Martorello, Big Game Program Manager (A)
- Paul Wik, Wildlife Biologist (T)

USDA Forest Service

- Tim Schommer, Forest Biologist, Wallowa-Whitman National Forest (A)
- Mark Penninger, District Wildlife Biologist, Wallowa-Whitman National Forest (T)

USDI Bureau of Land Management

- Tom Rinkes, Wildlife Biologist, Idaho State Office(A)
- Craig Johnson, Wildlife Biologist, Salmon-Clearwater Resource Area (T)

Wild Sheep Foundation

- Neil Thagard, National Conservation Director (A)
- Lloyd Oldenburg/ Rick Brigham, Idaho and Washington Chapters (T)

Acknowledgments

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research projects conducted at Washington State University. Many other individuals and organizations continue to assist the Hells Canyon Initiative in numerous ways and they are greatly appreciated.

Summary

The Hells Canyon Initiative is a state, federal, and private partnership to restore Rocky Mountain bighorn sheep *Ovis canadensis canadensis* in the Hells Canyon area of Oregon, Idaho, and Washington. This report covers 2009 – 2010, including the state fiscal year; July 1, 2009 – June 30, 2010, and the bighorn sheep biological year; June 1, 2009 – May 31, 2010. During this period, 118 radio-collared bighorn sheep were monitored regularly in 12 populations. Average annual survival of radio-collared ewes was 0.90 and annual ram survival was 0.78. Summer lamb survival ranged from 0 – 78% and summer survival and recruitment were highly variable among populations. Pneumonia-caused mortality of lambs was confirmed in 5 populations and suspected in 3 others. Sixty-four additional bighorn sheep were captured, sampled for health-testing, and collared with VHF and/or GPS collars in 2010. Seven hundred and seventeen bighorn sheep were observed in ground and aerial surveys and the overall metapopulation was estimated at 840 bighorn sheep, essentially unchanged from an estimate of 830 sheep in 2008 - 2009.

We continued to emphasize managing disease in bighorn sheep by minimizing exposure to pathogens associated with pneumonia. The Hells Canyon Initiative project provided data, technical support, and management input on analyses of public lands domestic sheep grazing. We also provided information to private sheep and goat owners and other members of the public, and removed bighorn sheep when they were at risk of contact with domestic sheep or goats. No bighorn sheep were moved into or out of the metapopulation.

Multi-year collaborative projects were continued with the University of Idaho Caine Veterinary Teaching Center and the Department of Veterinary Microbiology and Pathology at Washington State University to better understand the clinical causes of disease, in particular *Mycoplasma ovipneumoniae*, in bighorn sheep. An experiment co-pasturing bighorn and domestic sheep was completed during this period and two manuscripts are in preparation. A new collaboration was also started with Penn State University to analyze the spatial and temporal ecology of disease in the Hells Canyon bighorn sheep metapopulation.

Introduction

The Hells Canyon Initiative was started in 1995 as a program to accelerate restoration of bighorn sheep in Hells Canyon and the surrounding areas of Idaho, Oregon, and Washington and to focus research applicable to bighorn sheep restoration and management throughout the western United States and Canada. The concept was formalized in 1997 with the completion of an interagency memorandum of agreement and restoration plan (Hells Canyon Bighorn Sheep Restoration Committee 1997, 2004).

Project Area

The Hells Canyon Initiative project area encompasses 2,273,194 ha (5,617,062 ac) in the Snake River drainage in Oregon, Idaho, and Washington from the mouth of Clearwater River, Idaho, south to Brownlee Reservoir. It is bounded on the east by the hydrologic divide between the Salmon and Snake rivers near Riggins, Idaho, south to Brownlee Creek on the Payette National Forest, Idaho, and extends

just west of the Eagle Cap Wilderness, Wallowa-Whitman National Forest, Oregon. Major drainages include the Snake, Grande Ronde, Imnaha, and lower Salmon rivers. There are currently 16 bighorn sheep populations, or herds, established in the project area. Over 1.3 million acres (24%) of the project area is potential bighorn sheep habitat, 68% of which is publicly owned, primarily managed by the U.S. Forest Service (USFS). Other public land managers are the states of Oregon, Idaho, and Washington and the Bureau of Land Management (BLM).

Population Monitoring

One hundred eighteen radio-collared bighorn sheep (82 ewes, 36 rams) were monitored in 12 populations from 1 June 2009 to 31 May 2010. We located radio-collared ewes weekly from mid-April through May to determine productivity and as needed over the summer to document summer lamb survival, and we monitored movements and survival of all sheep approximately biweekly yearround. We also captured and radio-collared additional bighorn sheep via helicopter netgun and at a corral trap during this reporting period.

Adult survival

Sixteen radio-collared adult (>2 yr old) bighorn sheep (8F, 8M) died during this period in the Asotin (4), Black Butte, Imnaha, and Lostine (3 ea) Mountain View (2), and Muir Creek, Redbird, and Upper Hells Canyon, Oregon (1 ea) populations. Cause of death could be determined for 11 animals. Known causes of mortality were injuries due to trauma associated with falling (4), cougar predation or probable predation (4), and harvest (3 rams; Mountain View, Asotin, and Imnaha) (Figure 1). One of the sheep that died from trauma (Black Butte) also had chronic bronchopneumonia. Averaged over the metapopulation, annual survival of radio-collared ewes was 0.90 (72/82) and rams was 0.78 (28/36). By population, annual survival of ewes in populations (7) with 5 to 15 radio-collared females ranged from a low in Black Butte and Asotin of 83%, to 89% at Imnaha, and 100% in Lostine, Redbird, Sheep Mountain, and Wenaha (Tables 1 and 2).

An uncollared ram at Sheep Mountain got trapped in a fence near Brownlee reservoir and died during the fall of 2009. This was the only ram observed in this small population and no ewes were seen with lambs in 2010.

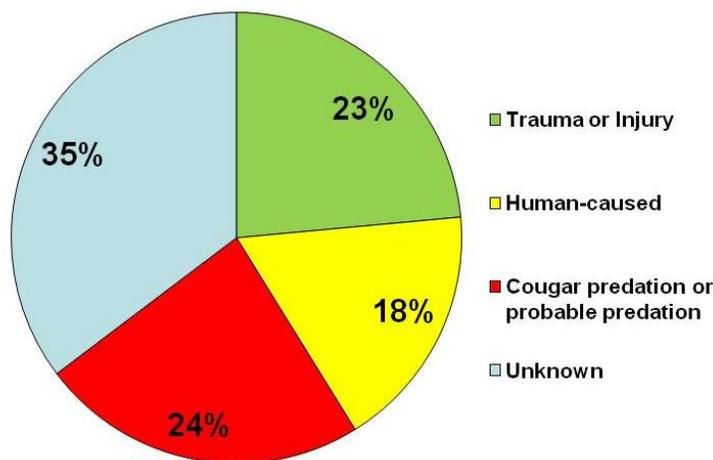


Figure 1. Causes of mortality of adult radio-collared bighorn sheep (n = 16) in Hells Canyon, 1 June 2009 to 31 May 2010.

Table 1. Annual survival of radio-collared ewes in 10 Hells Canyon bighorn sheep populations, 1 June 1997 to 31 May 2010. Sample sizes 2009 – 2010 in parentheses.

<i>Year</i>	<i>Black Butte</i>	<i>Redbird</i>	<i>Wenaha</i>	<i>Asotin</i>	<i>Lostine</i>	<i>Imnaha</i>	<i>Big Canyon</i>	<i>Muir Creek</i>	<i>Mountain View</i>	<i>Sheep Mountain</i>
1997-1998	0.92	1	0.91							
1998-1999	1	1	1	0.88			1	1		
1999-2000	0.58	1	1	0.86			0.93	0.93		
2000-2001	0.71	1	0.73	1	1	0.86	0.57	0.67		
2001-2002	0.80	0.92	1	1	1	1	1	1		
2002-2003	1	0.91	1	0.80	0.94	1	0.88	0.50		
2003-2004	0.84	0.73	0.75	0.83	0.94	0.80	0.29	0.88		
2004-2005	0.75	1	1	0.80	0.81	0.92	1	1		
2005-2006	1	0.91	0.89	0.88	0.80	0.91	1	0.78		
2006-2007	1	0.86	0.93	0.73	0.88	1	1	0.86	1.00	1
2007-2008	0.93	0.91	0.62	1	0.92	0.80	1	1	0.60	0.88
2008-2009	0.75	1	1	1	1	0.56	0.70	1	1.00	0.71
2009-2010	0.83	1	1	0.83	1	0.89		1	0.67	1
	(10/12)	(15/15)	(7/7)	(10/12)	(12/12)	(8/9)		(3/3)	(2/3)	(5/5)
Average	0.85	0.94	0.91	0.88	0.93	0.87	0.86	0.89	0.82	0.90

Table 2. Annual survival of radio-collared rams in 9 Hells Canyon bighorn sheep populations, 1 June 1997 to 31 May 2010. Sample sizes 2009 – 2010 in parentheses.

<i>Year</i>	<i>Black Butte</i>	<i>Redbird</i>	<i>Wenaha</i>	<i>Asotin</i>	<i>Lostine</i>	<i>Imnaha</i>	<i>Big Canyon</i>	<i>Muir Creek</i>	<i>Mtn View</i>
1998-1999							1	1	
1999-2000							1	1	
2000-2001	1	1	0.67		0.80	0.67	0.80	0.50	
2001-2002	0.8	0.80	1		1	1	0.75	0.50	
2002-2003	0.30	0.75	1		0.80	1	0.33		
2003-2004	0.50	0.83	1	0.8	0.80	0.67	1	1	
2004-2005	1	0.60	0.88	0.75	0.83	0.67	1	1	
2005-2006		1	1	0.33	1	0.50		1	
2006-2007	1	0.83	0.83	1	0.78	0.83			1
2007-2008	1	0.75	0.71	0.60	1	0.63	1		0.67
2008-2009	1	0.83	0.86	0.92	0.88	0.83			1
2009-2010	0.75 (6/8)	1	1	0.82	0.86	0.60			
		(5/5)	(4/4)	(9/11)	(6/7)	(3/5)			
Average	0.83	0.83	0.88	0.78	0.82	0.81	0.79	0.87	0.78

Lamb Survival

Lamb survival was highly variable among populations. In 2009, with the exception of the Imnaha population, summer lamb survival in the 5 populations where lambs were diagnosed with pneumonia was 50% or less (Tables 3, 4), and recruitment in these populations ranged from 0 to 33 lambs/100 ewes (Table 5). Pneumonia-caused lamb mortality was suspected in another 4 populations where summer survival was 0 – 33% and recruitment was 0 to 16 lambs/100 ewes (Table 5), although no dead lambs were recovered.

Table 3. Observed productivity and summer lamb survival in 9 herds in Hells Canyon, 2009.

Herd	No. radio-collared ewes observed with lambs (%)		Summer survival ^a
Asotin Creek, Washington	9/12	(75)	78%
Big Canyon, Idaho	1/1	(100)	0%
Black Butte, Washington/Oregon	10/11	(91)	10%
Imnaha, Oregon	8/9	(89)	63%
Lostine, Oregon	8/12	(67)	0%
Mtn View/Wenaha, WA/ OR	8/10	(80)	20%
Muir Creek, Oregon	2/3	(67)	33%
Redbird, Idaho	9/15	(60)	44%
Sheep Mountain, Oregon	3/5	(60)	33%

^a Survival from birth to 1 October. Herds in bold are those where lambs were diagnosed with pneumonia



Ewes and lambs in the Muir Creek population.

Table 4. Dead pneumonic bighorn lambs submitted to the Washington Animal Diagnostic Laboratory (WADDL) June 1, 2009 – May 31, 2010.

<i>Animal ID</i>	<i>WADDL ID</i>	<i>Mortality Date</i>	<i>Herd</i>	<i>Sex</i>	<i>Age (approx days)</i>	<i>Weight (kg)</i>	<i>Mycoplasma ovipneumoniae PCR</i>
09OR04	2009-5924	5/25/2009	Sheep Mt	F	21	7.38	Neg
09OR05	2009-6303	6/3/2009	Mt View	F	28	7.8	No test
09OR08	2009-6844	6/15/2009	Mt View	F	28	7.3	Pos
09OR07	2009-6844	6/17/2009	Sheep Mt	F	9	5	Neg
09ID01	2009-7171	6/24/2009	Redbird	M	35	5.7	Neg
09WA01	2009-7615	7/8/2009	Black Butte	F	56	8	Pos
09WA02	2009-7927	7/14/2009	Black Butte	M	56	11	Pos
09WA03	2009-7927	7/14/2009	Black Butte	M	56	9.8	Pos
09OR10	2009-7995	7/16/2009	Imnaha	M	56	9.7	No test



Sick lambs in the Lostine and Black Butte populations, July 2009.

Capture, radiocollar, and sampling

Sixty-four bighorn sheep were captured and radio-collared in February and March 2010. Fifty-seven (36F, 21M) bighorn sheep were captured by helicopter netgun (Quicksilver Air, Peyton, CO), sampled, radio-collared, and released February 8 – 13. The capture was conducted collaboratively by Idaho Department of Fish and Game, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, Wallowa-Whitman and Umatilla National Forests, State of Idaho Bureau of Land Management, and the Wild Sheep Foundation. Additional funding was provided by Shikar-Safari Club International. Another 7 bighorn sheep (6F, 1M) were captured in a corral trap in the Wallowa Mountains Lostine population by the Oregon Department of Fish and Wildlife. This brought the total number of collared sheep in the project area to 111 females and 50 males.



Results of health sampling were similar to previous years. A low frequency of titers to RSV was reported in the Snake River and Wenaha/Mountain View areas while none were positive in in the Imnaha population. Six of 7 sheep sampled in the Lostine were positive for exposure to RSV. Positive titers to parainfluenza-3 occurred in all areas, prevalence was lowest in the Snake River. Seventy percent of sheep had titers greater than 60 to *M.ovipneumoniae* indicating exposure although some seronegatives occurred in each population (Table 5).

Table 5. Antibody titers to Bovine Respiratory Syncytial Virus (RSV), Parainfluenza-3 virus (PI-3), and *Mycoplasma ovipneumonia* (*M. ovi*) in 64 bighorn sheep sampled in Hells Canyon, February and March 2010.

Area	No. Sheep	RSV ^a	PI-3 ^a	<i>M. ovi</i> ^b
Snake River	22	18% (8 – 32)	27% (8 – 32)	57 (-13 – 82)
Imnaha	14	0	57% (4 – 64)	61 (35 – 80)
Wenaha/Mt. View	21	19% (4 - 32)	86% (4 – 128)	65 (16 – 80)
Lostine	7	86% (16 - 32)	71% (4 – 32)	59 (3 - 82)
Total	64			

^a Reported as % positive (range of positive titers).

^b Reported as average titer (range). WADDL classifies an *M. ovi* elisa value of 60 or greater as positive.

Table 6. Prevalence of Pasteurellaceae and *Mycoplasma ovipneumoniae* bacteria in the nose and throat, *Protostrongylus* spp. lungworm larvae in feces, and test and observational results for *Psoroptes* mites in 64 bighorn sheep sampled in Hells Canyon, February and March 2010.

Area	No. Sheep	<i>Mycoplasma ovipneumoniae</i>	<i>Bibersteinia trehalosi</i>	<i>Mannheimia haemolytica</i>	<i>Pasteurella multocida</i>	<i>Protostrongylus</i> (lpg)	<i>Psoroptes</i> Test (obs)
Snake River	22	14% (3)	77% (17)	41% (9)	14% (3)	1.3	4 (10)
Imnaha	14	14% (2)	50% (7)	7% (1)	0	1.3	1 (8)
Wenaha/Mt. View	21	19% (4)	86% (18)	50% (9)	24% (5)	5.6	0 (11)
Lostine	7	15% (1)	57% (4)	57% (4)	0	1.0	0 (0)
Total	64	16% (9)	72% (46)	36% (23)	13% (8)	30%	5 (29)

Bibersteinia (Pasteurella) trehalosi was commonly detected in the upper respiratory tract in of sheep in all areas sampled. *Pasteurella multocida* was isolated infrequently from sheep in the Snake and Grande Ronde River populations (Wenaha/Mountain View). *Mycoplasma ovipneumoniae* and *Mannheimia haemolytica* bacteria were detected at low prevalence throughout the capture area. *Protostrongylus* larvae were detected in low numbers in in the feces of about a third of the individuals sampled. Scabies mites (*Psoroptes* spp.) were observed in most populations. Mites were only reported on 5 ear swabs submitted to WADDL although mild to moderate scabies infection was observed in nearly half (29/64) of the sheep sampled (Table 6).

Although in some populations, levels of copper, iron, and zinc in blood and serum were slightly to significantly lower than the laboratory “reference range” from Puls (1994) there is no information on trace element requirements in bighorn sheep. Selenium and calcium levels in all populations were considered “normal”, except the Lostine which was higher than reference (Table 7).

Health sampling Hells Canyon bighorn sheep capture, February 2010



Table 7. Average levels (ug/g) of trace elements in blood (selenium Se), and serum (Calcium Ca, Copper Cu, Iron Fe, Magnesium Mg, Potassium P, Zinc Zn) in 63 bighorn sheep sampled in Hells Canyon, February and March 2010.

Area	n	Se	Ca	Cu ^b	Fe ^b	Mg	P	Zn ^b
Snake River	21	0.15	94.84	0.84	1.57	28.09	67.52	0.66
Imnaha	14	0.19	97.24	0.81	1.52	29.36	64.06	0.80
Wenaha/Mt. View	22	0.11	92.77	0.74	1.48	27.24	54.05	0.64
Lostine	6	0.39 ^a	105.23 ^a	0.61	1.31	23.83	47.68	0.57
Total	63							

^a Mean is higher than University of Idaho Analytical Sciences Laboratory (UIASL) reference range.

^b Mean is lower than UIASL reference range.

Population Monitoring

The state wildlife agencies of Idaho, Oregon, and Washington conducted surveys from a helicopter (Robinson 44 and Hiller 12E) and on the ground in 2009-2010 to estimate total population size. Approximately 840 bighorn sheep are estimated to occur in 15 herds or populations within the project area (Table 8). There was little change in numbers from last year. Visibility of bighorn sheep in Hells Canyon is relatively high. Overall, 81% of groups and 87% of bighorn sheep are observed in helicopter surveys. We are currently seeking to incorporate a sightability model we have developed for bighorn sheep in Hells Canyon into a software program to better estimate population size and to obtain confidence limits on the estimate. We were unsuccessful at working with the University of Idaho to incorporate our model into existing user interface software “Aerial Survey” and are looking for other options.

Rams on the Snake River in Hells Canyon, aerial survey February 2010



Table 8. Hells Canyon bighorn sheep population counts, 2009-2010.

Population	Survey date(s)	Total	Ewes	Lambs	Rams	Estimated population ^e
Asotin, WA ^{a,c}	2/19/10	100	46	17	37	105
Bear Creek, OR ^c	7/15/09	42	22	12	8	50
Big Canyon, ID ^{a,b}	3/14/10	22	12	3	7	25
Black Butte, WA/OR ^{a,b}	2/26/10	44	29	3	12	65
Lostine, OR ^{a,c}	2/1/10	54	34	3	17	60
Lower Hells Canyon, OR ^b	<i>No date</i>	30	19	3	8	35
Lower Imnaha, OR ^{a,c}	3/31/10	118	73	18	27	135
Mtn View/Wenaha, WA/OR ^{a,b}	2/16 – 2/19/10	91	50	10	31	120
Muir Creek, OR ^{a,b}	3/14/10	24	13	5	6	35
Myers Creek, ID ^c	12/9/09	8	5	0	3	10
Redbird, ID ^{a,b}	3/10/10	109	59	17	39	115
Upper Hells Canyon, OR ^{c,d}	3/31/10	21	13	1	7	30
Upper Saddle Creek, OR ^{b,d}	3/31/10	19 ^d	9	2	3	35
Sheep Mountain, OR ^{a,c}	3/31/10	10	9	1	0	10
Upper Hells Canyon, ID ^c	4/14/10	8	4	0	4	15
Total		717				843
Average						56

^a Populations monitored intensively under the Hells Canyon Initiative.

^b Aerial survey.

^c Ground and/or fixed wing count

^d Upper Hells Canyon and Upper Saddle Creek populations are intermingled. For this report, Upper Saddle Creek includes animals observed on the canyon rim near Hat Point, and Upper Hells Canyon includes animals observed from Hells Canyon Reservoir to Sand Creek.

^e Wildlife biologist estimate, sightability model not used.

Disease Management

The Payette National Forest released a Final Environmental Impact Statement and record of decision on domestic sheep grazing in July 2010. The decision was to phase out some allotments in the northern and western part of the Forest including all allotments in Hells Canyon. The Bureau of Land Management Cottonwood Resource Area also has domestic sheep grazing allotments intermingled with the Payette National Forest allotments. They will be incorporating some aspects of the analysis done by the Payette National Forest into their Resource Management Plan for domestic sheep grazing.

The Umatilla National Forest has been evaluating grazing on the North End Allotment on the Grande Ronde River near the Wenaha bighorn sheep population. The Forest purchased some Argos-GPS radio-collars to monitor movements of the Wenaha bighorn sheep relative to this allotment that were deployed in February 2010 (Figure 2). The Wallowa-Whitman National Forest issued a record of decision on the West Side Environmental Impact Statement. The selected alternative provides approximately 8 miles of separation between bighorn and domestic sheep. A patch of suitable bighorn sheep habitat exists between the allotment and the Wenaha bighorn sheep population. A communications plan is in place in the event that domestic sheep separate from the main flock, or if bighorn sheep are detected close to the allotment.

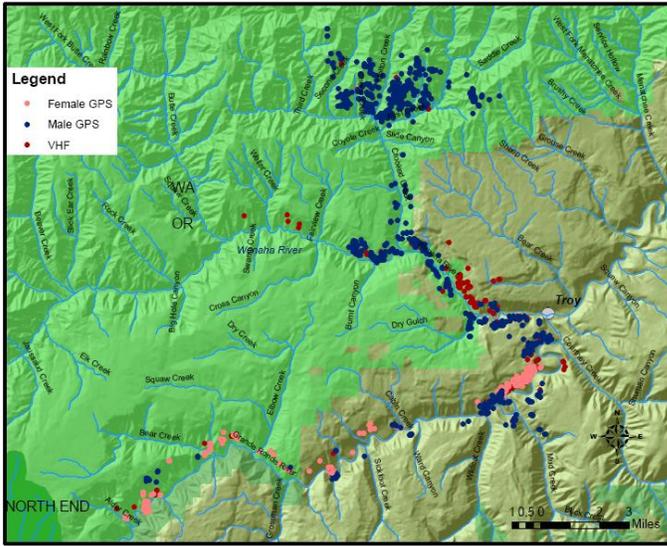


Figure 2. Wenaha GPS and VHF locations on and near the Umatilla National Forest, Feb – June, 2010

A yearling ram showed up near the town of Asotin, WA near some domestic goats at the end of May 2010. It appeared unlikely that he had contacted the goats, so the Washington Dept. of Fish and Wildlife, with assistance from Idaho, darted the ram, collected samples, put on a GPS collar and released him outside town. He was located the next day, and could not be found after that. A ground search was unsuccessful and we were unable to locate him

from the air due to weather. Finally, two weeks later the weather cleared and he was located near a group of domestic sheep north of Asotin. Coincidentally, the same day, a member of the public reported that they saw him in with the domestic sheep. Since he was in close contact with the domestic sheep and we do not have access to a holding facility or other options, he was lethally removed. The carcass was necropsied at WADDL and he was healthy. Data from the GPS collar showed that he had moved 13 miles and spent a week on Weissenfels ridge south of town before moving in with the domestic sheep the day before he was reported and located.

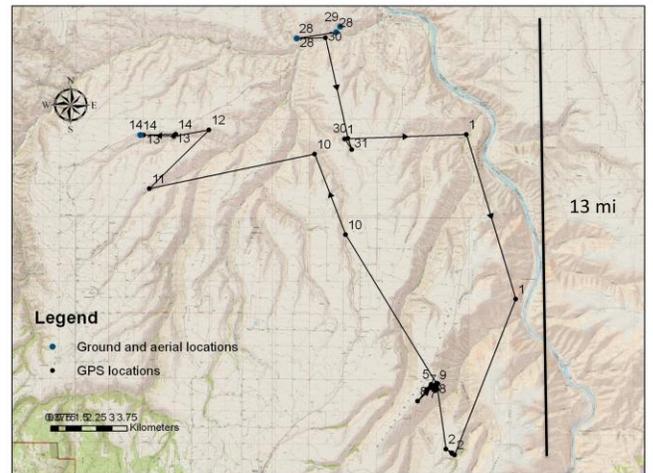
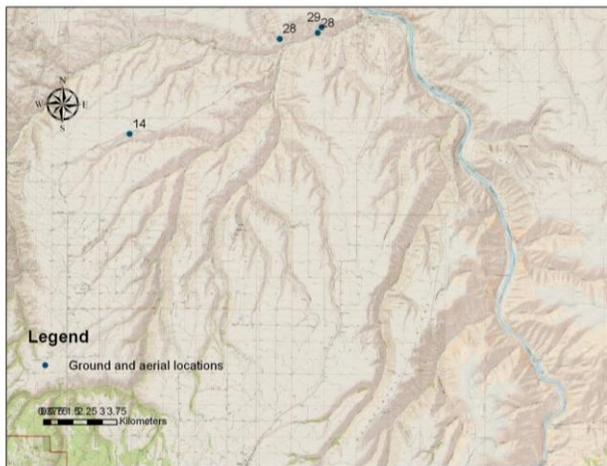


Figure 3. VHF (left) and GPS (right) locations of a yearling ram captured in Asotin May 28 and removed from a pen of domestic sheep on June 14, 2010. The VHF locations failed to detect a 13 mile movement to the south that occurred over a 2 week period.

Disease Research

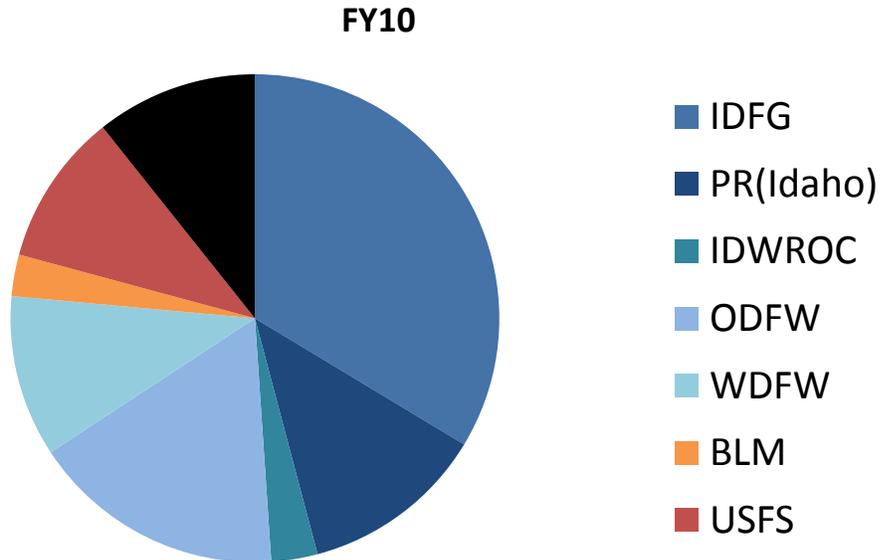
Collaborative research projects continued between the Hells Canyon Initiative bighorn sheep restoration project, the University of Idaho Caine Veterinary Teaching Center, and WSU College of Veterinary Medicine to combine field data from Hells Canyon bighorn sheep, laboratory analyses, and experiments to better understand causes of pneumonia in bighorn sheep.

In 2009 - 2010, a primary research focus was a captive experiment to test the role of *Mycoplasma ovipneumoniae* in bighorn sheep pneumonia associated with domestic sheep contact. This organism has been associated with pneumonia in many bighorn sheep populations (Besser et al. 2008). Previous experiments in which bighorn and domestic sheep were commingled cumulatively resulted in pneumonia in 88 of 90 (97.8%) of the bighorn sheep within 100 days, while bighorn sheep similarly commingled with other ungulates experienced only sporadic fatality (9 experiments, 4 of 56 animals, 7.1% mortality). *Mycoplasma ovipneumoniae* is host-specific for Caprinae, is widely carried by domestic sheep, and has been associated with pneumonia of wild bighorn sheep. We hypothesized that the presence of this organism may be a primary initiating cause of pneumonia in bighorn sheep.

When we commingled *M. ovipneumoniae*-free domestic and bighorn sheep (N=4 each) for 100+ days, one bighorn sheep died with acute *Mannheimia haemolytica* pneumonia on day 90 but the others remained healthy, a survival rate markedly different ($P= 0.002$) from previous bighorn-domestic sheep contact studies, and similar to bighorn sheep survival in previous contact studies with other ungulates. After 104 days, we experimentally infected one of the commingled domestic sheep with *M. ovipneumoniae*, inducing epizootic pneumonia in the three remaining bighorn sheep. The disease was severe but non-fatal. A single *M. ovipneumoniae* strain type was detected in the nose of all domestic and bighorn sheep, and the lungs of pneumonic bighorn sheep at necropsy. Some strains of Pasteurellaceae (*Mannheimia haemolytica* and *Bibersteinia trehalosi*) isolated from the lungs of pneumonic bighorn sheep were indistinguishable from strains detected pre-commingling in only the domestic sheep, and others were indistinguishable from strains detected pre-commingling in only the bighorn sheep. Finally, we found retrospective evidence of *M. ovipneumoniae* involvement in previous domestic sheep – bighorn sheep commingling experiments in the form of *M. ovipneumoniae* specific 16S rDNA sequences and seroconversion to *M. ovipneumoniae* in sera from a bighorn sheep that survived commingling. Overall, these results suggest *M. ovipneumoniae* is a primary pathogen of epizootic pneumonia in bighorn sheep commingled with domestic sheep. Pasteurellaceae are capable of acting as secondary opportunistic infections in *M. ovipneumoniae*-induced pneumonia and sporadically as primary agents of pneumonia in the absence of *M. ovipneumoniae*.

A second disease-related project that was initiated in 2009-2010 involves a retrospective analysis of population and health data in the bighorn sheep metapopulation. This project is being undertaken in collaboration with Penn State University. We hope to describe the disease syndrome as it occurs in natural conditions and examine the relative role of outside introduction of pathogens vs. transmission among bighorn sheep populations within the metapopulation in perpetuating pneumonia in bighorn sheep in Hells Canyon. This project is being funded by the David H. Smith Conservation Research Fellowship program <http://www.conbio.org/smithfellows/fellows/2009/plowright/> and the Morris Animal Foundation <http://www.morrisanimalfoundation.org/our-research/studies.html>.

Funding



Approximately \$315,000 was spent directly restoring bighorn sheep and conducting research on factors limiting the population in Hells Canyon in 2010. The states of Idaho (IDFG), Oregon (ODFW), and Washington (WDFW) provided about ¾ of the funding primarily through bighorn sheep special tag funds. Idaho also used some Pittman-Robertson (PR) funding and some Idaho funding was allocated through the Idaho Wildlife Disease Research Oversight Committee (IDWROC). BLM contributed funding through the challenge cost-share program and the Umatilla National Forest purchased Argos GPS collars for monitoring Wenaha bighorn sheep. Non-governmental (NGO) sources of funding included Shikar-Safari Club International, Nevada Bighorns Unlimited - Reno, and the Oregon Chapter of the Foundation for North American Wild Sheep.

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